

SALES ENGINEERING BULLETIN**PRINCIPLES OF RESISTANCE SOLDERING**

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Bulletin No. 1 of a Series

Engineers and shop personnel are familiar with electric arc welding to the extent it is well understood a closed circuit must be established between the power source, in series through the work, and thence back to the power source. The same electrical circuiting requirement maintains in all resistance soldering applications. Common practice refers to one side of the circuit from the work back to the power source as the "ground" connection, although it should be clearly understood that this in no sense refers to "ground" as the expression is used in building wiring, radio chassis work, etc.

It should also be understood that while the electrical circuit is identical to that used in electric arc welding, resistance soldering never employs an arc between the soldering electrode and work. The soldering electrode is held firmly in contact with the work.

The basic electrical principle involved in resistance soldering is shown in Figure 1. A heavy duty step-down transformer is arranged with its primary winding connected to line voltage supply and secondary connected through grounding plate or clip, work and soldering handpiece in a closed series circuit. The electrical design of the transformer provides for a large reduction in voltage and corresponding increase in amperage in the secondary circuit. All Wassco power units provide adjustable output (secondary) voltage ranges of approximately one to seven volts and secondary current densities from ten to three hundred or more amperes.

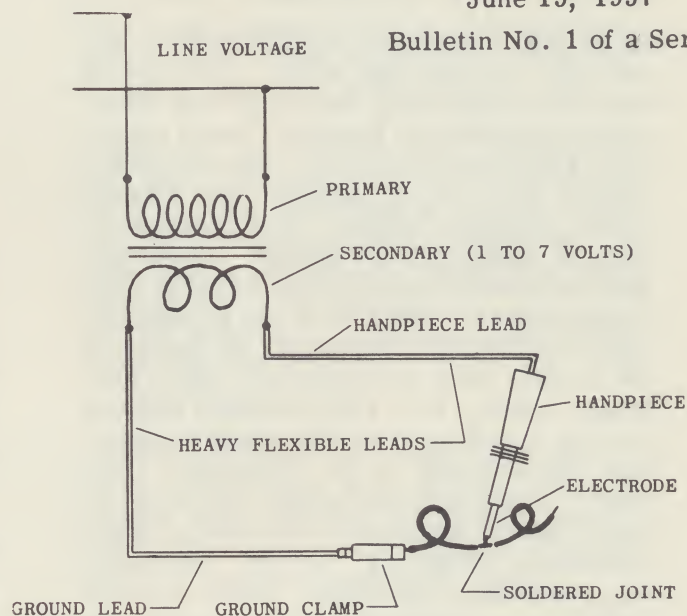


FIGURE 1

When a heavy current is passed through relatively high resistance soldering electrode materials such as carbon or special metal alloys, the electrode tip heats rapidly. This heat is conveyed by conduction to the work. In most resistance soldering applications an additional heat generating factor is the sometimes appreciable increase in temperature created within the metal parts of the joint being soldered due to the electrical resistance of the parts.

Obviously, the shape of the electrode tip can be varied widely to suit configuration of work. In general, electrodes should be shaped so that as much of the electrode as possible is in direct firm contact with the metal parts of the joint being soldered. In practice, in electrical work where a wire is being soldered to a terminal, it is only practical to take all possible steps to pre-

sent as much firm surface contact as possible between electrode and terminal, rely on heat rise in terminal generated by conduction of electrode heat (plus internally developed heat) to flow solder and flux on to the terminal and thence to the wire.

While there is a necessary limit to the variety of handpieces, fixtures, etc., commercially available and as manufactured by Wassco, there is literally no limit to the special types that can be designed for special applications by the user. Many types of specially shaped single and double tip soldering handpieces and fixtures are in use.

As stated, a complete circuit must be established through the work. This can be done many times with dual electrode handpieces and fixtures. However, much resistance soldering is done with single tip handpieces, such as for example the Wassco #10511, #10520 or #10521. It is essential to keep in mind that the ground connection must be established metalically to the joint to be soldered. There must not be electrically conductive components in series in the circuit such as resistors, electronic tubes, diodes, etc. There are two reasons for this, the first being that most components particularly in the electronic field have a relatively low current carrying capacity and can not support the flow of heavy resistance soldering current. Secondly, the resistance developed would prevent satisfactory soldering. For example, the ground connection can not be made to one terminal of a potentiometer and soldering attempted at another terminal.

Heat developed in the secondary circuit is dependent on current flowing and varies directly as the square of the current. The formula, $\text{Heat} = I^2 R$, applies. It becomes apparent that it is of first importance that maximum regulation be available if resistance soldering is to be efficiently applied. Wassco bench type power units #105-B2 (500 watts) and #105-C1 (1000 watts) are equipped to supply 24 different output voltages ranging from 1.0 to 5.8 on the 105-B2 and 1.2 to 6.9 on the 105-C1. A typical performance curve for the 105-C1 power unit is shown in Figure 2. It can be noted, for example, that with output set at 1.2 volts heat output is approximately 32 watts. By

increasing setting to 1.6 volts (a 25% increase) heat is more than doubled at approximately 65 watts.

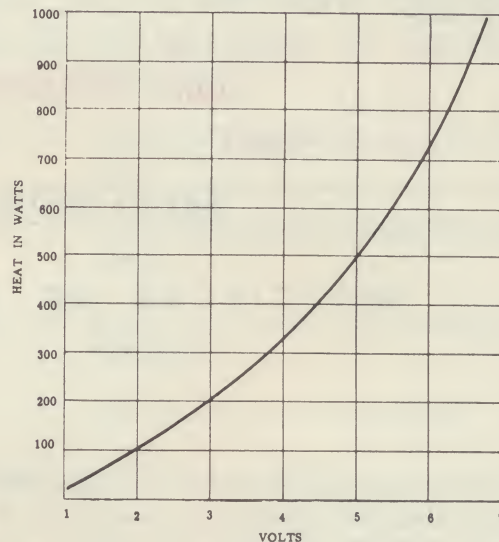


FIGURE 2

To further increase the efficiency of Wassco equipment all carbon electrodes are copper plated to increase current density down as close to the working tip as possible. However, in no case must the copper coating of the electrode be allowed to come in contact with the work, as this would short circuit the heating effect of the electrode.

Wassco bench type power units #105-B2 and #105-C1 are wired as shown in Figure 3. Note that secondary winding of the transformer and circuiting is completely isolated electrically from primary. Note both primary and secondary are tapped for maximum output flexibility. The 24 output voltages (heat outputs) are obtained by connecting ground lead and handpiece to any pair of the three output terminals in combination with setting the 8-point selector switch at any desired point. There is no polarity in the secondary circuit. That is handpiece and ground lead can be connected interchangeably with any pair of output terminals.

Note also that #10519 Foot Switch as shown in Figure 3 may be interposed between the power unit plug and line voltage outlet. On many applications it is best practice to use a foot switch for further precise control of heat input to work and this, of course, eliminates the necessity of making and breaking contact between work and elec-

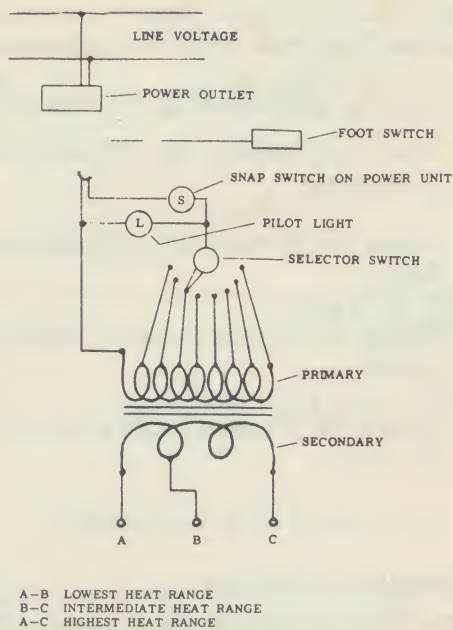


FIGURE 3

trode. Use of a foot switch is doubly important on extremely light work and is also particularly advantageous where the wire to be soldered to a terminal is not mechanically locked to same. The electrode is held in contact with joint holding wire in place and the heat turned off by means of the foot switch while the solder is allowed to harden.

A necessary requirement in all soft soldering work is that the work surfaces be clean. Procedures to accomplish this are well known by those familiar with soldering techniques and include chemical pickling, degreasing, mechanical brushing or sanding and other methods of removing foreign matter and oxides. It is usually best to have surfaces to be soldered electroplated or hot tin dipped. With some types of plating it is important that the plating be fresh, as even properly plated surfaces can develop oxides and other surface films which prevent efficient soldering.

The action of soldering fluxes is twofold in that first, the flux acts to clean and remove surface oxides and secondly, to protect the surfaces and keep clean while the soldering action is taking place. This fluxing action is insured in all resistance soldering procedures, as electrodes used can

not be tinned and thus it is mandatory that both solder and flux be flowed directly to the work. Improperly trained or supervised workers when using conventional electric irons frequently will flow both solder and flux to the tip of the iron and thence to the work. Under such conditions the flux is evaporated on the tip of the iron and does not supply proper fluxing action to the work.

The inherent efficiency and money and work-saving features of resistance soldering equipment are well worth careful study by competent engineers to analyze every possibility of establishing ground connections by jigs and/or fixtures which hold the work and establish the ground connection by spring contacts, mating plugs, etc.

In general, for all soft soldering applications it is only necessary to set heat output to a value sufficient to develop a dull red color in the tip of the electrode. A white heat is not necessary and many times inadvisable. The exception to this is in brazing and silver soldering applications where the full white heat of the electrode is sometimes required.

Carbon electrodes can be easily re-dressed to correct shape or preferred shape on a small disc grinding or sanding machine using a fairly coarse grit production-type cloth disc. (aluminum oxide, etc.).

The end result is relatively unskilled workers, when using resistance soldering equipment, can quickly be taught to produce high quality, well sweated and well covered soldered joints and due to the nature of the process will maintain such quality consistently at a high level. Rosin joints, cold joints, etc., are eliminated as no solder will flow to joint unless same is hot enough to melt the solder and cause flow. A top quality homogeneous joint always results. Burning of insulation next to joint is minimized, as the soldering takes place in a shorter time.

To summarize-

Adequate heat developed instantly, and intensely at point of contact between work and electrode. Hence, soldering operations are performed faster.

Heat is developed only at the tip of electrode while actually soldering. Hence, the shank of electrode and other portions of handpiece stay relatively cool and will not damage surrounding insulation.

Resistance Soldering Handpieces are substantially lighter than conventional electric irons. Workers produce more, with less fatigue.

No solder is consumed maintaining tinning of the working tip and hence an appreciable saving in solder usage is effected.

Carbon electrodes last two to three times longer (and can be purchased at lower cost) than either solid copper, alloyed copper or armored tips as used on conventional irons.

Much less power is used, as the heavy soldering current flow maintains only while actually soldering.

Handpieces cool off quickly when laid aside. Fouling of air with flux fumes and accidental burn hazards are held to a minimum.

Absolute control of heat input to work is easily maintained with Wassco equipment.

Other bulletins to follow in this series:

No. 2 - The Economics of Resistance Soldering.

No. 3 - Using the Wassco Bench Soldering Sets.

No. 4 - Using the Wassco Panel Attachments.

No. 5 - Using the Wassco 10580 Soldering Machine.

And others to be announced.

Other literature available:

"Lead to-Pin Soldering by Resistance and Conduction Methods"-reprinted from October, 1955, Electrical Manufacturing Magazine.